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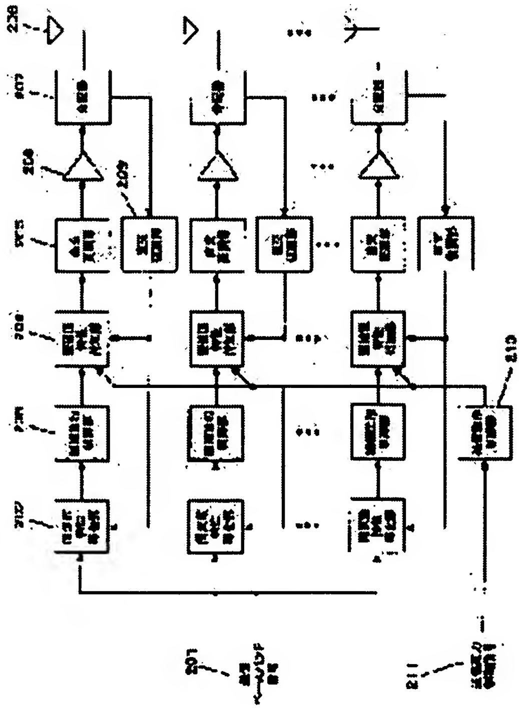
(54) ARRAY ANTENNA SYSTEM



(57)Abstract:

PROBLEM TO BE SOLVED: To improve power efficiency of an array antenna system and to miniaturize the system by performing non linear distortion compensation on power amplifiers included in respective systems in the array antenna device and to form a highly accurate beam by compensating the linear dispersion of the power amplifier between the systems.

SOLUTION: Distortion compensation characteristic adding parts 204 and frequency characteristic equalizing parts 202 are arranged for compensating non-linear distortion generated in the power amplifiers 206 of the respective

systems and compensating frequency distortion in the respective systems. The parameters of the distortion compensation characteristic adding parts 204 and the frequency characteristic equalizing parts 202 are adaptively updated by feeding back the outputs of the power amplifiers 206 through distributors 207.

LEGAL STATUS

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used for the transmitter of a radio communications system, and relates to array antenna equipment equipped with the nonlinear distorted compensator with which nonlinear distortion generated by the transmitting system is compensated.
[0002]
[Description of the Prior Art] In the power amplifier contained in the transmitter of a radio communications system, nonlinear distortion occurs according to the amplitude of a sending signal. While a transmission characteristic deteriorates by this nonlinear distortion, adjacent channel interference arises. Although what is necessary is just to use power amplifier with high linearity in order to reduce this nonlinear distortion, the power amplifier which generally produces nonlinear distortion from the field of power efficiency is used. The improvement in power efficiency leads to the miniaturization of equipment, and low-power-ization.
[0003] Conventionally, various methods, such as feedforward, a KATE cyanogen loop formation, and PURIDISU torsion, are proposed as an approach of compensating this nonlinear distortion.
[0004] The configuration of the nonlinear distorted compensator by the conventional PURIDISU torsion method is shown in drawing 3 . For transmitting baseband signaling and 302, as for the frequency-conversion section and 304, a distorted compensation property adjunct and 303 are [301 / power amplifier and 305] antennas. In the distorted compensation property adjunct 302, the distorted reverse property generated with power amplifier 304 according to the amplitude value of the transmitting baseband signaling 301 is added to the transmitting baseband signaling 301. And in the frequency-conversion section 303, frequency conversion of the output of the distorted compensation property adjunct 302 is carried out to RF band, and it is amplified by even desired level in power amplifier 304. The linearity signal with which distortion was compensated appears in the output of power amplifier 304, and it is transmitted from an antenna 305.
[0005] On the other hand, as an antenna contained in the transmitter of a radio communications system, the array antenna which controls the directivity by arranging two or more antennas at equal intervals is known. It becomes possible to form a sharp directive beam in the direction of arbitration by use of an array antenna, the repeat distance of the same frequency is contracted, and the use effectiveness of a frequency can be raised.
[0006] The configuration of conventional array antenna equipment is shown in drawing 4 . For transmitting baseband signaling and 402, as for the frequency-conversion section and 404, the amplitude phase control section and 403 are [401 / power amplifier and 405] antennas. The transmitting baseband signaling 401 receives control of the amplitude for forming a beam in desired

include-angle width of face and the direction of desired in the amplitude phase control section 402, and a phase. And it is changed into RF band by the frequency-conversion section 403, and the output of the frequency-conversion section 403 is amplified by even desired level in power amplifier 404, and is transmitted from an antenna 405.

[0007] Although it is the configuration of having power amplifier about each network, in drawing 4 , the configuration which prepares the amplitude phase control section in the latter part of power amplifier using what has common power amplifier is also considered as another configuration. In the case of the latter, although the number of power amplifier requires only one, a thing large-sized as power amplifier at high power is required.

[0008]

[Problem(s) to be Solved by the Invention] In order to perform highly precise beam formation for each conventional network in the array antenna equipment which has power amplifier, high linearity is required for each power amplifier. It is because it becomes difficult to change the amplitude level of each network and to acquire a desired beam property when nonlinear distortion occurs in each power amplifier. However, use of power amplifier with high linearity will cause the decline in power efficiency, and enlargement of equipment.

[0009]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, in this invention, the power amplifier which produces nonlinear distortion is used for each network of array antenna equipment, and nonlinear distorted compensation is performed to this power amplifier. Highly precise beam formation is attained by securing the linearity of the power amplifier between networks at the same time this attains the improvement in power efficiency of the whole array antenna equipment, and the miniaturization of equipment. By this invention, the further highly precise beam property is acquired by compensating also to the frequency distortion generated in each network in addition to a nonlinear distorted compensation generated with power amplifier.

[0010]

[Embodiment of the Invention] In the array antenna equipment which has two or more antenna element and two or more power amplifier, invention of this invention according to claim 1 is array antenna equipment characterized by having the distorted compensation property adjunct for compensating nonlinear distortion generated with power amplifier about said all or some of power amplifier, and while it can attain the improvement in power efficiency, and the miniaturization of equipment, it has the operation from which a highly precise beam property is acquired.

[0011] Invention according to claim 2 is array antenna equipment characterized by for the distorted compensation property adjunct of each network responding to transmitted power, and being able to start or suspend the actuation alternatively in array antenna equipment according to claim 1, and while having the same operation as claim 1, about power amplifier with small distorted generating, it has the operation which reduces power consumption by suspending nonlinear distorted compensation actuation.

[0012] Invention according to claim 3 is array antenna equipment characterized by being power amplifier with the maximum output value from which the power amplifier of each network differs respectively in array antenna equipment according to claim 1, and it has the operation which enables the miniaturization of the further equipment by preparing the power amplifier suitable for the maximum transmitting output value which changes with each networks while it has the same operation as claim 1.

[0013] It is array antenna equipment characterized by controlling transmitted power when invention according to claim 4 performs gain control by the distorted compensation property adjunct of each network in array antenna equipment according to claim 1, and while having the same operation as claim 1, it has the operation which enables highly precise transmitted power control by performing transmitted power control in consideration of nonlinear distortion generated with power amplifier.

[0014] In array antenna equipment according to claim 1, invention according to claim 5 is array antenna equipment characterized by having the frequency-characteristics identification section for compensating the frequency distortion in each network, and it has the operation which enables highly precise beam formation by compensating also about dispersion in the frequency characteristics between networks while it has the same operation as claim 1.

[0015] It is array antenna equipment characterized by for invention according to claim 6 to perform nonlinear distorted compensation to either of claims 1-5 accommodative by the distorted compensation property adjunct of each network in the array antenna equipment of a publication using the feedback signal from power amplifier, and while having the same operation as claims 1-5, it has the operation which enables nonlinear distorted compensation actuation stabilized also to fluctuation of operating environment, such as temperature and supply voltage.

[0016] Invention according to claim 7 is set to array antenna equipment according to claim 5. It is array antenna equipment characterized by performing nonlinear distorted compensation and frequency distortion compensation accommodative using the feedback signal from power amplifier in the distorted compensation property adjunct and the frequency-characteristics identification section of each network. While having the same operation as claim 5, it has the operation which enables the nonlinear distorted compensation actuation and frequency distortion compensation actuation which were stabilized also to fluctuation of operating environment, such as temperature and supply voltage.

[0017] Hereafter, the gestalt of operation of this invention is explained using drawing 1 and drawing 2 .

[0018] (Gestalt 1 of operation) Drawing 1 is the block diagram of the array antenna equipment in the gestalt of operation of this invention 1st. 101 -- transmitting baseband signaling and 102 -- the frequency-characteristics identification section and 103 -- for the frequency-conversion section and 106, as for an antenna and 108, power amplifier and 107 are [the amplitude phase control section and 104 / a distorted compensation property adjunct and 105 / a compensation actuation control section and 109] transmitted power control signals.

[0019] About the array antenna equipment constituted as mentioned above, the actuation is explained using drawing 1 . First, the transmitting baseband signaling 101 is inputted into the frequency-characteristics identification section 102, and compensation of the frequency distortion generated in each network is performed. The frequency-characteristics identification section 102 can be constituted with a transversal filter. The output of the frequency-characteristics identification section 102 receives control of the amplitude required for beam formation, and a phase in the amplitude phase control section 103, and the output of the amplitude phase control section 103 is inputted into the distorted compensation property adjunct 104. The nonlinear distorted reverse property generated with power amplifier 106 according to the amplitude value of an input signal in the distorted compensation property adjunct 104 is added to an input signal. The configuration of the distorted compensation property adjunct 104 is a configuration which prepares the memory which stored the nonlinear distorted reverse property beforehand, and reads the reverse property by making amplitude value of an input signal into the address.

[0020] The output of the distorted compensation property adjunct 104 is changed into the signal of RF band in the frequency-conversion section 105, and the output of the frequency-conversion section 105 is amplified by even required level in power amplifier 106. And the linearity signal with which distortion was compensated is outputted from power amplifier 106, and the beam which the signal transmitted from the antenna 107 was compounded spatially, and had desired directivity is formed.

[0021] On the other hand, in the compensation actuation control section 108, desired transmitted power is obtained by controlling to each distorted compensation property adjunct 104 based on the information on the transmitted power control signal 109. This control is performed by changing the read-out address range of the memory in which the reverse property of power amplifier was stored according to the desired transmitted power value, and carrying out the multiplication of the constant according to a desired transmitted power value to the read multiplier value. When distortion generated in power amplifier 106 by transmitted power control becomes small and nonlinear distorted compensation becomes unnecessary, actuation of the distorted compensation property adjunct 104 of each network may be stopped alternatively. Moreover, power amplifier 106 does not need to use the same power amplifier in each network, and should just prepare the power amplifier which fulfills the maximum output value assumed in each network in each network.

[0022] Dispersion of the linearity which originates in the nonlinear distortion of the power amplifier in each network by the above actuation, and dispersion of the frequency characteristics between networks are compensated, and the array antenna equipment which enables highly precise beam formation is obtained. Moreover, the improvement in power efficiency and the miniaturization of equipment can be attained by performing nonlinear distorted compensation of each power amplifier.

[0023] (Gestalt 2 of operation) Drawing 2 is the block diagram of the array antenna equipment in the gestalt of operation of this invention 2nd. 201 -- transmitting baseband signaling and 202 -- the frequency-characteristics identification section and 203 -- the amplitude phase control section and 204 -- a distorted compensation property adjunct and 205 -- for a distributor and 208, as for the rectangular recovery section and 210, an antenna and 209 are [the quadrature modulation section and 206 / power amplifier and 207 / a compensation actuation control section and 211] transmitted power control signals.

[0024] About the array antenna equipment constituted as mentioned above, the actuation is explained using drawing 2 . First, the transmitting baseband signaling 201 is inputted into the frequency-characteristics identification section 202, and compensation of the frequency distortion generated in each network is performed. The frequency-characteristics identification section 202 can be constituted with a transversal filter. The output of the frequency-characteristics identification section 202 receives control of the amplitude required for beam formation, and a phase in the amplitude phase control section 203, and the output of the amplitude phase control section 203 is inputted into the distorted compensation property adjunct 204. The nonlinear distorted reverse property generated with power amplifier 206 according to the amplitude value of an input signal in the distorted compensation property adjunct 204 is added to an input signal. The configuration of the distorted compensation property adjunct 204 is a configuration which prepares the memory which stored the nonlinear distorted reverse property beforehand, and reads the reverse property by making amplitude value of an input signal into the address.

[0025] The output of the distorted compensation property adjunct 204 is changed into the signal of RF band in the quadrature modulation section 205, and the output of the quadrature modulation section 205 is amplified by even required level in power amplifier 206. And the linearity signal with which distortion was compensated is outputted from power amplifier 206, and the beam which the signal transmitted from the antenna 208 was compounded spatially, and had desired directivity is formed.

[0026] Moreover, a part of signal distributed by the distributor 207 is fed back, and it is inputted into the rectangular recovery section 209. In the rectangular recovery section 209, a rectangular recovery is performed, IQ baseband signaling is outputted, and it is inputted into the distorted compensation property adjunct 204 and the frequency-characteristics identification section 202. In the distorted compensation property adjunct 204, the value of the nonlinear distorted reverse property stored in memory using said IQ baseband signaling is updated accommodative. Moreover, also in the frequency-characteristics identification section 202, the tap multiplier of a transversal filter is updated accommodative using said IQ baseband signaling.

[0027] On the other hand, in the compensation actuation control section 210, desired transmitted power is obtained by controlling to each distorted compensation property adjunct 204 based on the information on the transmitted power control signal 211. This control is performed by changing the read-out address range of the memory in which the reverse property of power amplifier 206 was stored according to the desired transmitted power value, and carrying out the multiplication of the constant according to a desired transmitted power value to the read multiplier value. When distortion generated in power amplifier 206 by transmitted power control becomes small and nonlinear distorted compensation becomes unnecessary, actuation of the distorted compensation property adjunct 204 of each network may be stopped alternatively. Moreover, power amplifier 206 does not need to use the same power amplifier in each network, and should just prepare the power amplifier which fulfills the maximum output value assumed in each network in each network.

[0028] By the above actuation, dispersion of the linearity resulting from the nonlinear distortion of the power amplifier between networks and dispersion of the frequency characteristics between networks are compensated accommodative, are stabilized also to fluctuation of operating environment, such as temperature and supply voltage, and the array antenna equipment in which highly precise beam formation is possible is obtained. Moreover, the improvement in power efficiency and the miniaturization of equipment can be attained by performing nonlinear distorted compensation of the power amplifier of each network.

[0029]

[Effect of the Invention] While enabling the improvement in power efficiency of the whole array antenna equipment, and the miniaturization of equipment as mentioned above by performing nonlinear distorted compensation for each network to nonlinear distortion generated in each power amplifier in the array antenna equipment which has power amplifier according to this invention, highly precise beam formation is realizable by suppressing dispersion in the linearity between networks.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of the array antenna equipment by the gestalt of operation of this invention 1st
[Drawing 2] The block diagram of the array antenna equipment by the gestalt of operation of this invention 2nd
[Drawing 3] The block diagram of the conventional nonlinear distorted compensator
[Drawing 4] The block diagram of conventional array antenna equipment
[Description of Notations]
101,201 Transmitting baseband signaling
102,202 Frequency-characteristics identification section
103,203 Amplitude phase control section
104,204 Distorted compensation property adjunct
106,206 Power amplifier
107,208 Antenna
108,210 Compensation actuation control section
109,211 Transmitted power control signal
105 Frequency-Conversion Section
205 Quadrature Modulation Machine
207 Distributor
209 Rectangular Demodulator

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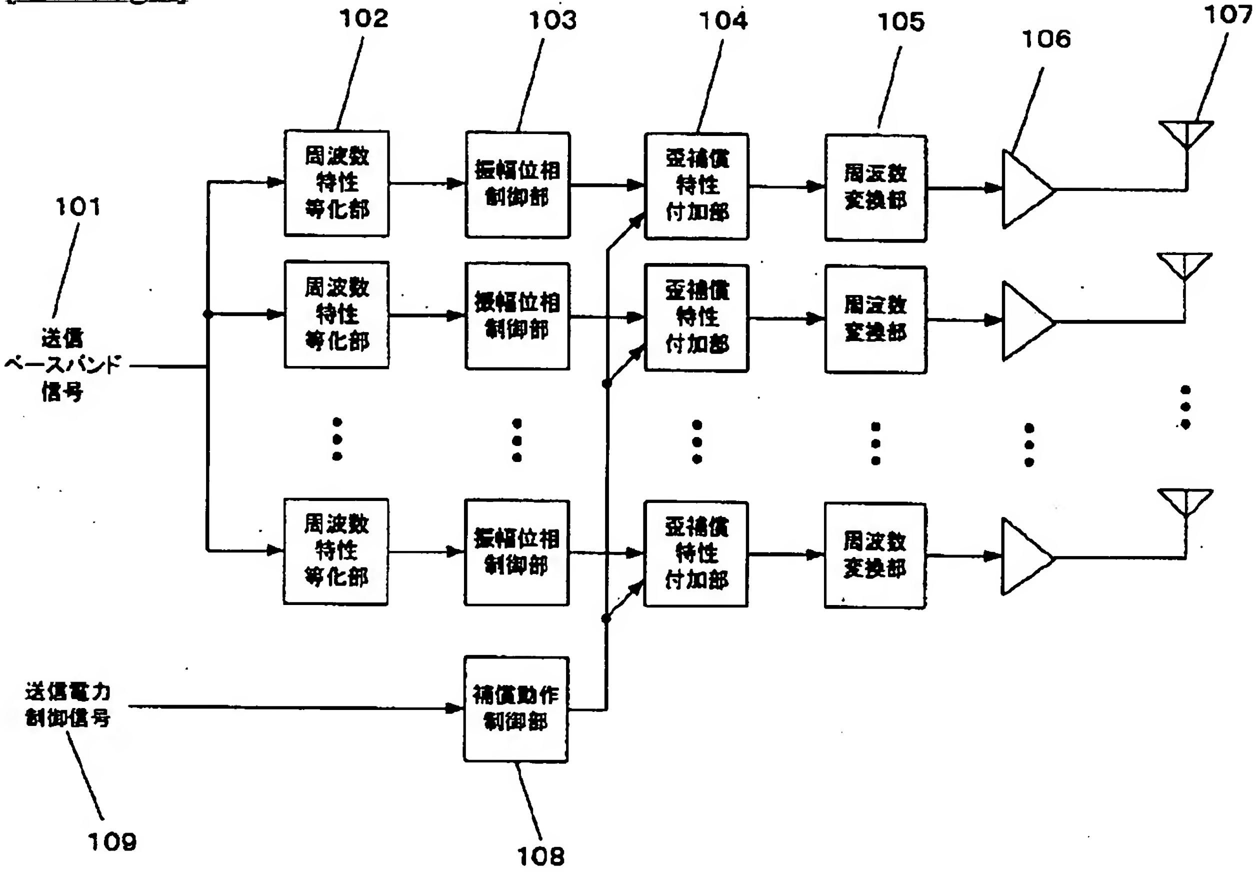
DRAWINGS

[Drawing 1]


102
103
104
105
106
107
101
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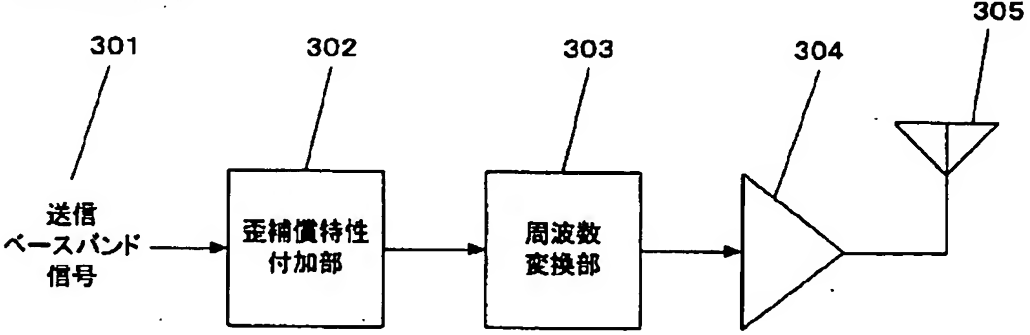
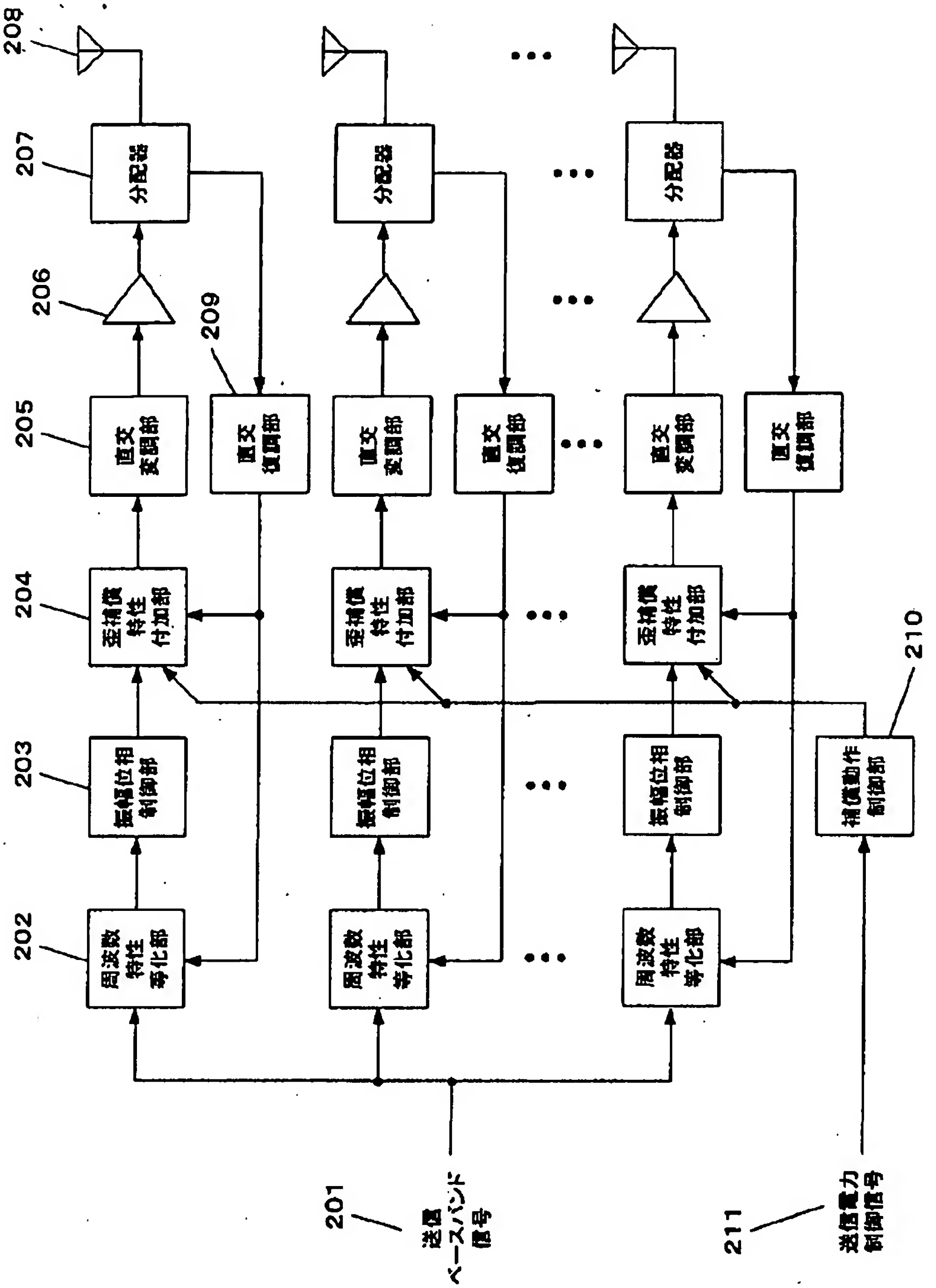
振幅位相制御部
歪補償特性付加部
周波数変換部
送信電力制御信号
補償動作制御部
109
108

[Drawing 3]


301
302
303
304
305
送信ベースバンド信号
歪補償特性付加部
周波数変換部

[Drawing 2]


201
送信ベースバンド信号
202
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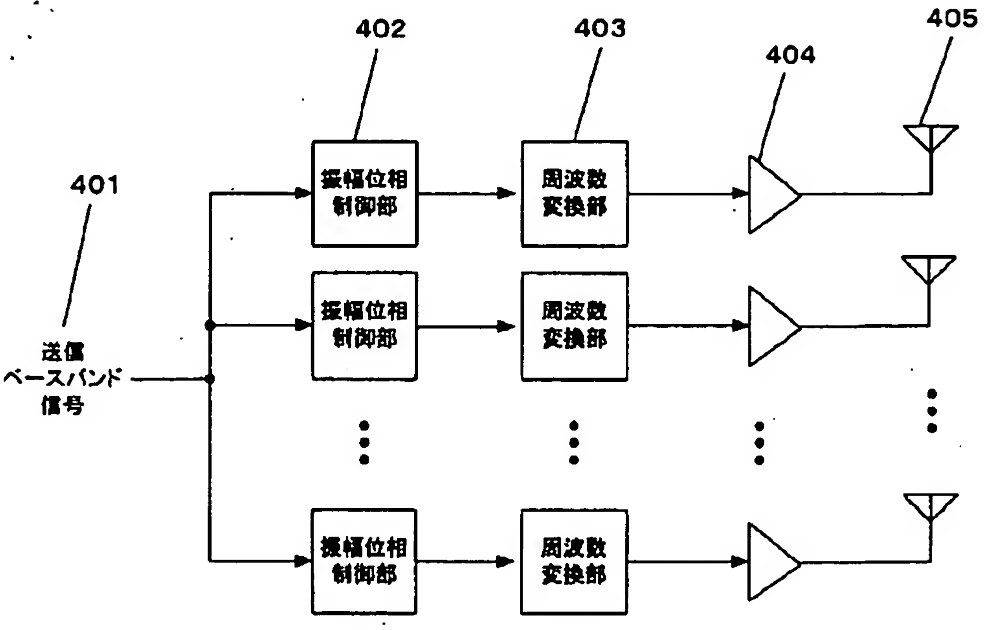
203
振幅位相制御部
204
歪補償特性付加部
205
直交変調部
206
207
分配器
208
209
直交復調部
210
補償動作制御部
211
送信電力制御信号

[Drawing 4]


402
403
404
405
401
振幅位相制御部
周波数変換部
振幅位相制御部
周波数変換部
送信ベースバンド信号
振幅位相制御部
周波数変換部

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CLAIMS

[Claim(s)]
[Claim 1] Array antenna equipment which has the distorted compensation property adjunct which compensates nonlinear distortion generated with power amplifier about all or some of two or more antenna elements, two or more power amplifier connected to each of two or more of said antenna elements, and said two or more power amplifier.
[Claim 2] A distorted compensation property adjunct is array antenna equipment according to claim 1 which responds to transmitted power, and starts or suspends the actuation alternatively.
[Claim 3] Two or more power amplifier is array antenna equipment with a respectively different maximum output value according to claim 1.
[Claim 4] Array antenna equipment according to claim 1 which controls transmitted power by performing gain control by the distorted compensation property adjunct.
[Claim 5] Array antenna equipment according to claim 1 which has the frequency-characteristics identification section which compensates frequency distortion.
[Claim 6] 5 is [claim 1 which performs nonlinear distorted compensation accommodative by the distorted compensation property adjunct using the feedback signal from power amplifier thru/or] array antenna equipment of a publication either.
[Claim 7] Array antenna equipment according to claim 5 which performs nonlinear distorted compensation and frequency distortion compensation accommodative using the feedback signal from power amplifier in the distorted compensation property adjunct and the frequency-characteristics identification section of each network.
[Claim 8] 7 is [claim 1 thru/or] a transmitter possessing the array antenna equipment of a publication either.
[Claim 9] The radio communications system containing a transmitter according to claim 8.

[Translation done.]